SUMMARY OF SAFETY AND EFFECTIVENESS DATA

I. General Information

Device Generic Name: Perinatal Monitoring System with Fetal Pulse Oximeter

Device Trade Name: Series 50 XMO Fetal/Maternal Monitor (Model M1350C) with Integrated Fetal Oxygen Saturation Monitoring System including the following components:

- M1350C Monitoring System with M1350C FSpO2 processing board
- M1365A Patient Module
- Nellcor OxiFirst™ Fetal Oxygen Sensor, Series FS14

Applicant's Name and Address:

Philips Medical Systems, Inc., Cardiac and Monitoring Systems
3000 Minuteman Road
Andover, MA 01810

Date of Panel Recommendation: None
Premarket Approval (PMA) Application Number: P020028

Date of Notice of Approval to the Applicant: January 3, 2003

The Philips Series 50 XMO Fetal/Maternal Monitor (Model M1350C) with Integrated Fetal Oxygen Saturation Monitoring System (Philips Series 50 XMO system) is a multi-parameter intrapartum monitoring system with a new optional mode for monitoring fetal oxygen saturation (FSpO2). Philips Medical systems, Inc., Cardiac and Monitoring Systems (Philips) integrated this new monitoring mode into its monitor in a joint development project with Tyco Healthcare/Nellcor Puritan Bennett, Inc. (Pleasanton, California). Note that Tyco Healthcare purchased Nellcor and Nellcor Perinatal Business subsequent to the approval of the OxiFirst™ fetal oxygen saturation monitoring system.

The PMA for this monitor includes a "Right of Reference Letter" from Nellcor that allows use of clinical and preclinical data submitted in Nellcor's PMA for the OxiFirst™ Fetal Oxygen Saturation Monitoring System, Model N-400 (P990053) in support of this new PMA. FDA approved the PMA for the OxiFirst™ monitor on May 12, 2000. Because Nellcor was involved in the design and testing of the three major components (circuit board, patient module, and sensor) for the fetal

oxygen saturation monitoring option used in the Philips Series 50 XMO systems and those components are the same or similar to those used for the Nellcor monitor, only limited additional clinical data was required. FDA's review of this PMA focused on the safety and effectiveness of integrating Nellcor's OxiFirst™ fetal oxygen saturation technology into the Philips monitor.

For more information on the data incorporated by reference, please refer to the Summary of Safety and Effectiveness Data (SSED) for PMA P990053. Written requests for copies of the SSED can be obtained from the Dockets Management Branch (HFA-305), Food and Drug Administration, 5630 Fishers Lane, rm. 1061, Rockville, MD 20857 under Docket # 00M-1448. This information can also be accessed via FDA's CDRH internet page located at http://www.fda.gov/cdrh/pmapage.html.

II. Indications for Use

The Philips Series 50 XMO Monitor continuously monitors intrapartum fetal oxygen saturation ($FSpO_2$) and the FSpO2 parameter is indicated **as an adjunct** to the fetal heart rate (FHR) monitoring in the presence of a non-reassuring heart rate pattern. It should only be used after amniotic membranes have ruptured and on a singleton fetus in vertex presentation with a gestational age greater than or equal to 36 weeks.

III. Contraindications

Do not use in patients with the following conditions:

- documented or suspected placenta previa;
- ominous FHR pattern requiring immediate intervention; or
- need for immediate delivery (unrelated to FHR pattern), such as active uterine bleeding.

IV. Warnings and Precaution

A listing of warnings and precautions can be found in the device labeling.

V. Device Description

Functional Components: The fetal pulse oximetry option (and components) was developed by Nellcor, and is used during labor and delivery to measure fetal oxygen saturation ($FSpO_2$). The fetal oxygen saturation monitoring portion of the Philips Series 50 XMO system consists of three components:

- OxiFirst™ Fetal Oxygen Sensor, FS14 (supplied by Nellcor),

- Philips M1365A Patient Module, and
- Philips Series 50 XMO Fetal/Maternal Monitor with M1350C FSpO2 processing board.

When indicated, the sensor is inserted transcervically into the mother's uterus and is positioned against the cheek or temple of the fetus. Two light-emitting diodes (LEDs) at the sensor surface shine light into fetal tissue and reflected light is received by an adjacent photodetector. Pre-processing of the FSpO2 signal occurs within the patient module which also serves to connect the sensor to the monitor. Hardware and software within the M1350C board in the monitor process this signal to determine the oxygen saturation and pulse rate of the fetus and assess the quality of the optical signals. The values of fetal oxygen saturation and optical pulse rate are displayed on the monitor's front panel (along with other indicators) and communicated to external equipment via serial and/or analog ports.

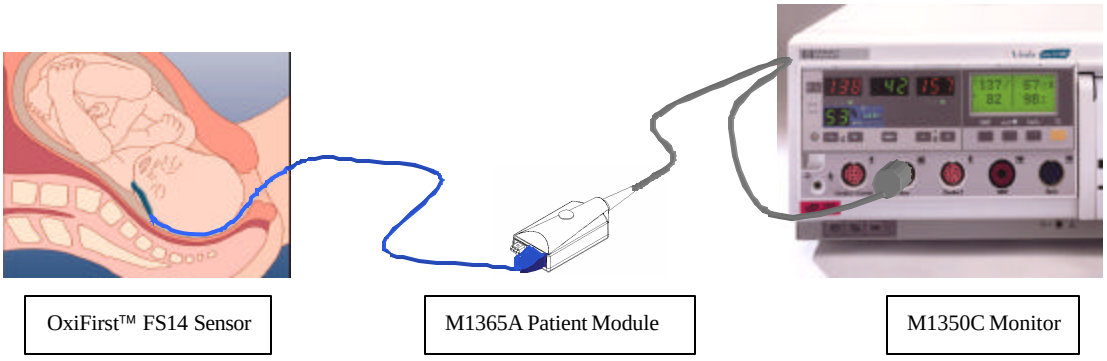

Figure 1: Diagram of the Philips Series 50 XMO System

Theory and Principles of Operation: The technology used in the fetal pulse oximetry option, like that of other pulse oximetry monitors, is based on two basic principles. The first is that oxyhemoglobin (O_2Hb) and deoxyhemoglobin (HHb) differ in their ability to absorb light according to wavelength. The second is that the volume of arterial blood in tissue (and hence, light absorption by that blood) changes during the pulsatile flow produced by each cardiac cycle. This device is similar to the basic adult pulse oximeter, re-engineered to optimize signal acquisition in the fetus in the uterine environment.

Class II Maternal/Fetal Monitoring Modes and Accessories

The Series 50 XMO Fetal/Maternal monitor is an intrapartum monitor that contains conventional maternal/fetal monitoring functions with the new FsPO2 function. The following conventional functions are included in the design of this device: Fetal heart rate (dual and external or internal), Maternal uterine activity (external or internal), Maternal Heart Rate, Maternal ECG, Maternal Non-invasive

pulse oximetry (MSpO2), Fetal Movement Profile, Maternal Non-invasive Blood Pressure (NBP).

VI. Alternative Practices and Procedures for Fetal Pulse Oximetry

Obstetricians in the United States today routinely use electronic fetal monitors during labor to track fetal heart rate and uterine contractions. Clinical palpation and auscultation are also used to assess the fetus during labor.

Fetal scalp pH and fetal scalp stimulation are also used as indirect measures of fetal oxygen levels.

VII. Marketing History for Fetal Pulse Oximetry

Philips has not marketed the Series 50 XMO with integrated fetal oxygen saturation monitoring in the United States or in any other country.

The Nellcor FS14 Fetal Oxygen Sensor was approved with the Nellcor N-400 monitor under P990053. It has been marketed by Nellcor internationally since March 1995. .

VIII. Potential Adverse Effects of the Fetal Pulse Oximetry Option on Health

Please refer to Nellcor SSED for P990053 for the summary of adverse events.

IX. Pre-Clinical Testing

Bench Validation. A comparison was conducted between the N-400 and M1350C fetal oximeters. Nellcor developed a test fixture called the Pulse II Simulator. This simulator is a device that uses a collection of various fetal oxygen saturation data to serve as a simulation of a patient. The data is a compilation of recordings from various monitoring sessions collected by Nellcor, as well as synthetic waveforms for a full workout of the system including a full range of O2 saturation values. The simulator feeds the data back to a patient module connection and is used to validate a given patient module/monitor combination (the sensor is replaced by this test device).

Bench testing was conducted with the use of this simulator. This testing produced data on the interpretation of the signal provided by the simulator for both the FSpO2 processing board installed in the Philips 50 XMO system and the N-400 (OxiFirst™ system). A data analysis was performed comparing the data from the two devices. Analyses were performed using a mixed model analysis (SAS) with all factors (monitors, runs, subjects) except type (of monitor) as random effects. Phillips demonstrated that the results of their monitor were highly correlated with paired results from the Nellcor N-400. Though there were

statistical differences between the 2 monitors, this was an artifact of the very large sample size used to compare the 2 monitors. It was also found that the few observed differences in monitor readings were random and sporadic and had no clinical impact.

Software: In the FSpO2 processing board, software responsibilities are divided between two microprocessors, the Oximetry Processor (OP) and the Communications Processor (CP). The OP is responsible for digitizing the sensor photodetector signal, determining if the sensor is in contact with the fetus, detecting pulsatile activity from the IR and Red plethysmographic waveforms, and computing and displaying saturation, pulse rate and signal quality. The CP is responsible for all serial and analog communication with external devices as well as communicating status information between itself and the OP. During its review of the relevant software, FDA applied the requirements for a "Moderate" level of concern in accordance with our software guidance document.[1]

Design verification consisted of audits, design reviews, code reviews, and testing at multiple levels to assure that design output matched design input. Design validation consisted primarily of testing (including the bench studies described above) to assure that the software is consistent with the intended use of the device. Verification and validation activities were evaluated and found to be sufficient to support approval of this device.

Standards. The Series 50 XMO monitor was tested by Philips to the following applicable standards: IEC 601-1, IEC-2-27 (ECG), UL 2601-1, CSA C22.2#601.1-M90, IEC 601-1-2, EN 55011:1997, IEC 1000-4-2:1995, IEC 1000-4-3, IEC 100-4-4:1995, and IEC 1000-4-5:1995. The device met these standards.

X. Human Factors

During development of the device, a three-phase user preference study was conducted on various versions of the user interface. All three phases asked the user to rate various aspects of the device according to how acceptable they were. The second and third phases involved use on actual patients. The third phase, conducted in Germany, used the final interface design.

Philips conducted a non-blinded survey/observational human factors study to address usability of the Series 50 XMO system in a clinical environment, focusing on fetal oximetry. The study was conducted at 2 sites with a total of 13 patients. After users were trained to use the device, they filled out a set of case report

[1] Center for Devices and Radiological Health, Guidance for the Content of Premarket Submissions for Software Contained in Medical Devices (May 29, 1998).

forms with questions regarding usability on each study case. These questions included: sensor insertion and positioning, FSpO2 display and operation, general operation of the monitor, general comments on the FSpO2 feature, and training. An observer was also used in one case and filled out a set of forms as well. More than 80% of the responses were "agree" or "strongly agree" in 11 of 14 evaluations. We determined that the test results show that the device performed adequately.

XI. Safety and Feasibility Studies

Please refer to the SSED for P990053 for information on the Safety, Biocompatibility, and Feasibility studies conducted.

XII. Summary of Pivotal Clinical Studies

Please refer to the SSED for P990053 for information on the Pivotal Clinical studies.

XIII. Conclusions Based on Study Objectives

In addition to the clinical validation provided by in the original PMA submitted by Nellcor, bench validation, and human factors studies were conducted to show that there was no significant difference in the performance of the N400 (Nellcor) and Series 50 XMO (Philips) systems. As stated before, the bench validation was conducted using a simulator and compared the performance of the N400 and M1350C FSpO2 processing systems. The data demonstrated that in a comparison of over 4000 observations that the two devices were highly correlated. Human factors testing, as stated before, evaluated the clinical response effects of the Series 50 XMO system. Human factors testing was determined to show that the device performed adequately.

XIV. Panel Recommendations

Pursuant to the provision of Section 515 (c) (2) of the Federal Food, Drug and Cosmetic Act (FD&C) as amended by the Safe Medical Devices Act of 1990, this PMA application was not referred to the Obstetrics and Gynecology Devices Panel, an FDA Advisory Panel Committee, for review and recommendation. FDA believes that the information in this PMA substantially duplicates information previously reviewed by this Panel when it considered the PMA for the OxiFirst™ monitor in January 2000.

XV. FDA Decision

CDRH determined that the results of the preclinical and clinical studies provide reasonable assurance of the safety and effectiveness of the Philips Series 50

XMO Fetal/Maternal Monitor (Model M1350C) with Integrated Fetal Oxygen Saturation Monitoring System when used as indicated in the labeling.

Philips Medical Systems, Inc. agreed to the post-approval requirement of a study to evaluate the effect of monitor use on Cesarean-section rates and certain other outcome measures as the monitor is introduced into the general clinical practice. Philips Medical Systems, Inc. also agreed to conduct a second post-approval study to assess human factors that may contribute to human errors during monitor use, especially with respect to misuse of the controls and misinterpretation of the displays. Philips Medical Systems, Inc. will also ensure that physician training is provided to new users, following the training plan outlined in the PMA.

Wherever labeling, training, promotion or advertising materials describe the effects of FSpO2 monitoring on Cesarean delivery rates, Philips agreed to include the following two essential elements:

- In a randomized clinical trial, use of the FSpO2 parameter (fetal oxygen saturation monitoring) as an adjunct to traditional FHR monitoring did not result in a reduction in the overall rate of deliveries by Cesarean-section. Cesarean deliveries for nonreassuring fetal status (NRFS) were *reduced* in the test group (FHR + $FSpO_2$).

- For reasons not explained by the study data, Cesarean deliveries for dystocia were *increased* in the test group to offset the reduction in Cesarean deliveries for NRFS.

CDRH found the applicant's manufacturing facilities to be in compliance with the device Quality System Regulation (21 CFR 820).

CDRH issued an approval order for the stated indication for the applicant's PMA for the Series 50 XMO Fetal/Maternal Monitor (model M1350C) with Integrated Fetal Oxygen Saturation Monitoring System on January 3, 2003

IX. Approval Specifications

Directions for use: See the labeling.

Hazards to Health from Use of the Device: See Indications, Contraindications, Warnings, precautions and Adverse Events in the labeling.

Post-approval Requirements and Restrictions: See approval order.